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ABEEHA AWAN
Xi'an Jiaotong-Liverpool University, China, abeeha.awan20@student.xjtlu.edu.cn

ŠIMON PROKOP
Czech Technical University in Prague, Czech Republic, simon.prokop@cvut.cz

JIŘÍ VELE
Czech Technical University in Prague, Czech Republic, jiri.vele.jv@gmail.com

THEODOR DOUNAS
Robert Gordon University, United Kingdom, t.dounas@rgu.ac.uk

DAVIDE LOMBARDI
Xi'an Jiaotong-Liverpool University, China, davide.lombardi@xjtlu.edu.cn

See next page for additional authors

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Authors

ABEEHA AWAN, ŠIMON PROKOP, JIŘÍ VELE, THEODOR DOUNAS, DAVIDE LOMBARDI, ASTERIOS AGKATHIDIS, and Lukas Kurilla

Abstract

With the advancement of augmented and virtual reality technologies both in scale as well as accessibility, the Metaverse (Stephenson, 1992, Hughes, 2022) has emerged as a new digital space with potential for the application of architectural creativity and design.With blockchain integration, the concept of the Metaverse shows promise in creating a “decentralised” space for design and creativity with rewards for its participants. As a platform that incorporates these technological components, does the Metaverse have utility for architectural design? Is there something truly novel in what the Metaverse brings to architectural computing, and architectural design? The paper constructs a qualitative knowledge graph that can be used for the evaluation of various kinds of Metaverses in and for architectural design. We use Design Science Research methods to develop the knowledge graph and its evaluative capacity, stemming from our experience with two Metaverses, Decentraland and Cryptovoxels. The paper concludes with a discussion of knowledge and practice gaps that are evident, framing the opportunities that architects might have in the future in terms of developing Metaverse(s).

Keywords

Metaverse, Virtual Reality, Digital space, Augmented Reality, Blockchain

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IS THE METAVERSE HYPE OR A PROMISING NEW FIELD FOR ARCHITECTS?

ABEEHA AWAN[1], ŠIMON PROKOP[2], JIŘÍ VELE[3], THEODOR DOUNAS[4], DAVIDE LOMBARDI[5], ASTERIOS AGKATHIDIS[6], AND LUKÁŠ KURILLA[7]

[1] Xi'an Jiaotong-Liverpool University, China
abeeha.awan20@student.xjtlu.edu.cn

[2] Czech Technical University in Prague, Czech Republic
simon.prokop@cvut.cz

[3] Czech Technical University in Prague, Czech Republic
jiri.vele.jv@gmail.com

[4] Robert Gordon University, United Kingdom
t.dounas@rgu.ac.uk

[5] Xi'an Jiaotong-Liverpool University, China
davide.lombardi@xjtlu.edu.cn

[6] University of Liverpool, United Kingdom
Asterios.agkathidis@liverpool.ac.uk

[7] Czech Technical University in Prague, Czech Republic
lukas.kurilla@cvut.cz

ABSTRACT

With the advancement of augmented and virtual reality technologies both in scale as well as accessibility, the Metaverse (Stephenson, 1992, Hughes, 2022) has emerged as a new digital space with potential for the application of architectural creativity and design. With blockchain integration, the concept of the Metaverse shows promise in creating a "decentralised" space for design and creativity with rewards for its participants. As a platform that incorporates these technological components, does the Metaverse have utility for architectural design? Is there something truly novel in what the Metaverse brings to architectural computing, and architectural design? The paper constructs a qualitative knowledge graph that can be used for the evaluation of various kinds of Metaverses in and for architectural design. We use Design Science Research methods to develop the knowledge graph and its evaluative capacity, stemming from our experience with two Metaverses, Decentraland and Cryptovoxels. The paper concludes with a discussion of knowledge and practice gaps that are evident, framing the opportunities that architects might have in the future in terms of developing Metaverse(s).

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ملخص

مع تقدم تقنيات الواقع المعزز والافتراضي من حيث الحجم وإمكانية الوصول، برزت تقنية الميتافرس كمساحة رقمية جديدة مع إمكانية تطبيق الإبداع والتصميم المعماري. وعن طريق إدماج تقنية البلوكتشين، أصبحت تقنية الميتافرس واعدة في إنشاء مساحة "لامركزية" للتصميم والإبداع مع إصدار مكافآت للمشاركين فيها. وهنل يكمن السؤال: كمنصة تضم هذه المكونات التكنولوجية، هل لدى الميتافرس فائدة بالنسبة للتصميم المعماري؟ هل هناك شيء جديد حقًا فيما تجلبه إلى مجال الحوسبة المعمارية والتصميم المعماري؟ تنشئ هذه الورقة البحثية رسمًا بيانيًا معرفيًا نوعيًا يمكن استخدامه لتقييم أنواع مختلفة من الميتافرس في التصميم المعماري ومن أجله. نستخدم فى هذا البحث أساليب بحث علوم التصميم لتطوير الرسم البياني للمعرفة وقدرته التقييمية والنابعة من تجربتنا مع اثنين من منصات الميتافرس: ديسنترالاند وكريبتوفوكسلز. تختتم الورقة بمناقشة الفجوات الواضحة فى كل من مجالى المعرفة والممارسة، وتأطير الفرص التي قد تكون للمعماريين في المستقبل من حيث تطوير عوالم الميتافرس.

الكلمات المفتاحية: الميتافرس، الواقع الافتراضى، الفراغ الرقمى، الواقع المعزز، تقنية البلوكتشين.

1. INTRODUCTION

Envisioned as the next evolution of the internet as part of the Web 3.0 system, the Metaverse (Stephenson, 2011) has emerged as a new space where architectural creativity and design can be applied. Etymologically a combination of the word 'meta' and 'universe', the Metaverse as a concept was first introduced in Stephenson's novel "Snow Crash" as a parallel digital universe where agents- (humans in our case) have a second life, distinct from their real one. Since then, the idea has appeared as a mainstay of science fiction media from the Matrix trilogy of films (Wachowski and Wachowski, 1999) to games like Cyberpunk 2077 (2020). Metaverse realities and interpretations have ranged from virtual utopias to dystopian warnings of the abuses of technology. Though distinct in its many iterations, the core concept of the Metaverse is a hypothetical version of the internet as a singular virtual world experienced with a life-like degree of immersion through virtual reality and augmented reality headsets.

Recent technological advancements have turned the Metaverse from a fictional hypothetical of science fiction to an achievable reality. In fact, the constituent technologies for the Metaverse have existed for a long time, in one form or another. Virtual and augmented reality technologies have steadily advanced in terms of performance, cost, and accessibility since their advent in the 1980s. Facebook, one of the world's largest tech and social networking companies, changed its name to Meta in 2021, announcing a renewed focus and influx of capital and resources in the development of the future of the Metaverse. As artists, designers, and architects have begun studying, experimenting, and creating with the immersive, virtual components of the Metaverse and its associated technologies, the Metaverse has shown new creative potential and collaboration. (Suzuki et al., 2020) Virtual reality lends architects an unprecedented understanding and access to space and design capabilities with automation, scripting, and 3D modelling. The integration of blockchain and the concept of decentralised commerce and ownership through NFTs and Metaverse real estate re-examine concepts of capital and ownership. Gamification and social networking allow clients, users, and creators alike to engage with architectural content through a variety of mediums and experiences.

However, these developments hide the danger and consequences that implementation of the Metaverse could bring, such as the 'sin of Déjà vu' (Maver, 1995), i.e recreating older ideas, failing to take into account failure or critically understanding what has come before us. The Metaverse could replicate and potentially augment many of the existing failures of pre-existing systems thus necessitating a framework from which to evaluate the unprecedented development of the system and its contingent technologies. Further, the limitations of the technologies themselves as well as the issues and complications created by human interaction with these elements must be considered for sustainable and ethical growth of the Metaverse as a concept.

Within the paper, we attempt to construct an evaluation framework of the Metaverse for architectural design, with the scope of making the Metaverse useful to architects, as either a space to design for or as a space to design in. The evaluation framework is structured in such a way to avoid bias and potential issues that arise from the current lack of validation, critique, and evaluation while maintaining a flexibility that may be adapted and refined as more Metaverse architecture projects and tools develop.

The paper introduces the concept with framing the problem and the hype of the Metaverse and its associated technologies and current innovations, before discussing the motivation for the paper. It details the construction of the evaluative knowledge graph, its justification, adaptability, and reasoning, with a specific focus on the Metaverse framework in relation to architecture as a principle, considering the key benefits, detriments, and potential applications of the concept for architects. The paper examines not only the Metaverse components of blockchain, virtual reality, and social networks but also the interaction of users, specifically design-focused architectural users with this system, namely through the use and understanding of virtual space, design and testing potentials, and education/social community building and interaction.

Finally, a conclusion and discussion section complete the paper with suggestions for future work and vectors to be developed with an eye on the future of not only the Metaverse but also architectural work in relation to it.

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2. PROBLEM FRAMING AND MOTIVATION - BEYOND THE HYPE OF THE METAVERSE.

Lee et al. (2021) provide an excellent review of the technological foundations and virtual ecosystem for creating a Metaverse, exploring the dimensions and potential impact of the Metaverse. Uniquely they introduce the Metaverse as an instance of a world in the physical to digital continuum, where the Metaverse is a continuation of a digital twin. This also follows the idea of the Crypto-Twin (REDACTED, 2022) where a Metaverse is a blockchain-enabled digital intelligent twin that can enable governance decisions in a physical space. Suzuki et al**.** (2020) propose the creation of a Metaverse as the convergence of Internet of things sensors, where research collaboration can thrive on a global level. Osivand (2021) discusses the building elements of the Metaverse and further speculates on the nature of further digital and cybernetic arts that can be created on the Metaverse, identifying this as a potential infrastructure. Thus, we observe that most discussions on the Metaverse are consumed with discussing the constituent parts (and this paper is not immune to this) and the speculative "what if" that we can build with the Metaverse. Within the Gardner Hype cycle, the two anticipatory constituents are the expectation cycle, i.e., where people expect technology will develop, and the actual technology s-curve, i.e., the actual development of a technology (Steinert and Leifer, 2010). Cheng et al. (2022) discuss in particular Metaverse hype, identifying early social virtual reality platforms as Metaverse prototypes, framing the hype around the technology but also critiquing specific implementations by Microsoft and Meta, framing, in the end, the opportunities and potential impacts: Securing and enabling Digital twins, User addiction and its management, the unsuitability of current 5G and network architectures for full realistic virtual representation and the issues of latency of both the network and IoT devices. Within this hype, the motivation for our paper stems from the need to establish a rigorous guide of the Metaverse for architects, when the Metaverse is used for or in architectural design.

3. BLOCKCHAIN AS INFRASTRUCTURE

Blockchain is a distributed network of computer nodes that collectively run a virtual state machine, where transactions can be recorded, and code can be run in the form of software classes code called smart contracts. Due to their reliance on cryptographic measures to record the transactions and changes to the state machine into blocks, the reliance on financial incentives to participate in the network, but also removing barriers to participation, blockchains are conceptualised as trust machines (Shyamasundar and Patil, 2018), able to offer to projects that use them the creation of peer-to-peer economies through crypto-economics. Within the crypto-economics envelope, one is able to create tokens, both fungible and non-fungible (i.e., unique, not interchangeable with another) that allow a complex utility to be constructed when used within a Metaverse or another digital universe. We consider the use of public, permissionless blockchain as critical infrastructure for the existence of the Metaverse, as without it, the Metaverse becomes a Virtual reality, a closed garden platform.

4. METHODOLOGY

Methodologically we used the lens of Design Science Research (DSR) to develop a knowledge graph that can be used by architects and researchers alike to evaluate Metaverses, either ones that have already been built or futures ones. Within DSR (vom Brocke et al., 2020) one uses empirical understand of the needs of an environment, in our cases the needs of architects operating in the digital space, and knowledge to rigorously construct theories and artefacts that are useful and provide innovative solutions to the aforementioned needs. In our case, we used our empirical knowledge of using two currently fully operational Metaverses, "decentraland" and "cryptovoxels", and the knowledge sourced from literature, to develop an artefact, the knowledge graph, that acts only as a basis for evaluation of other Metaverses. The DSR process contains five activities, 1. Problem Identification and Motivation, 2. Define the Objectives of the Solution, 3. Design and Development, 4. Demonstration and 5. Evaluation. Within Our approach we have completed activities 1 and 2 and our knowledge graph can be used as a framework for beginning activity 3, i.e. design and development. This means that architects seeking to create Metaverses that solve a problem or address a societal need can use our graph to guide the development of their solution and then use post ergo for evaluation at activity 5. An obvious constraint of our knowledge graph is the empirical basis on only two current Metaverses, however there are very few Metaverse platforms out there that are functional with a blockchain component that is a minimum requirement for a Metaverse to develop. We can further validate the graph by applying it to other Metaverses, but also, we can enrich it by incorporating missing features from new or improved technologies and solutions.

5. DEFINING THE CRITERIA IMPORTANT FOR ARCHITECTS

We have identified empirically by using Decentraland and Cryptovoxels a set of possible uses of the Metaverse for architecture, itemised below in no particular order.

Project visualisation / exploration

Marketing engagement, virtual portfolio, showcase

Pre-occupancy assessment

Orientation, UX, fire escape simulations,

Layout experience and optimisation tool

Public annotation of designs before construction

Competitions and Participatory Design exercises/voting by the public

Education of architects/engineers

Blockchain-based Digital Intelligent twin for large-scale buildings operations

Metaverse as a public discussion forum with an immersive 3D world able to show data visualisations, problematic areas, design proposals and design solutions

Testing environment for new (mixed) uses of buildings

Urban scale digital crypto-twin of a neighbourhood or a whole city

Further, the Metaverse must perform well in terms of certain criteria in order to be used for architectural work in the above use cases. We then group the criteria into 6 categories discursively: Platform, Visual Representation, Design capabilities, Level of Gamification, Blockchain integration and User experience. An analysis of the criteria follows.

Fig.1: Six Criteria in which Metaverse should be efficient for Architectural use cases.

5.1 Platforms

A Metaverse platform that is accessible will play a critical role in architects' decisions on what to use the Metaverse for. An example can be accessing it through Virtual Reality (VR) or even Augmented Reality if at the right physical spot, to present a design to clients. However, in the case of a live demo or a consultation, it might be much more efficient to simply use a standalone PC or Mac version depending on other software the architect uses. In the case of just marketing engagement for new clients the web browser version might turn

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out to be the most efficient due to the minimal amount of entry barriers. Even this short argumentation about use-cases signifies that a true Metaverse should not be bound to VR as some of the early definitions state.

5.2 Visual Representation

Some of the current Metaverse projects like Sandbox and Voxels (former Cryptovoxels) have the voxel stylized visuals which might seem like a modelling constraint, there exist issues of readability, relatability and understandability. In case of an example of user interaction in a design that is still under development, if the clients acknowledge that what they explore is stylized it can help keep the design process in the abstract for longer without focusing on not important details like furniture and fixtures. This is quite usually a serious problem for architects to keep clients in the abstraction long enough despite their desire to start deciding on details such as the tiles and door knob designs.

The main criteria are then the scale accuracy of objects and the spaces we experience. With this requirement, architects will be able to consult and present their real-world projects in the Metaverse. Taking the stylization into account we can form a realism scale which starts with heavily abstracted and stylized (circa 1 m sized voxels similar to Minecraft) through low-poly stylization, extrusions, and small voxels (or variable scale voxels similar Cryptovoxels), to detailed models, high-poly and realistic models. Higher stylization will affect the scale; however, higher realism is technically demanding in terms of computing resources both for the platform and the device of the user. We can therefore define a stylisation-realism gradient and use a scale to differentiate between different ways of rendering geometry.

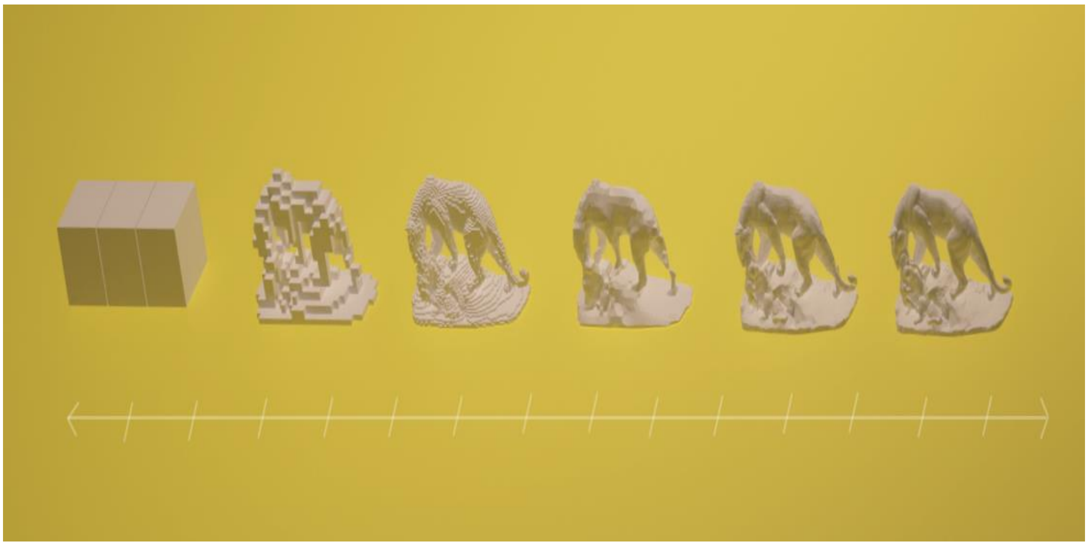

Fig.2: The Stylisation-Realism scale in modelling

5.3 Design Capabilities

5.3.1 3D Modelling Standards

The most important feature in this regard will be importing features and standards. The Metaverse Standards Forum was established in June 2022 and so far, all the significant Metaverse building companies seem to want to be involved in its discussion about standardisation (Lewis, 2022). The format in the centre of the discussion is USD (Universal Scene Description) initially invented by Pixar and brought to attention by being adopted by Apple AR applications (“Apple Open Source,” n.d.). The USD file can contain. glTF 3D models with physically based rendered materials which seem to be a popular candidate for web and lower-performance platforms. Making this format fully available and exportable in architecture CAD programs will be a huge advantage as well.

5.3.2 Modelling precision

Another important feature is precision modelling. This might include some form of adjustable snapping to principal axis directions which is present in all current architecture modelling software. What architects also need is the ability to input exact numbers when making an operation like move, scale and rotate. Without this feature, any modelling has to be strictly done prior to the Metaverse and this invalidates the interactivity for example in scenarios where one is sharing an immersive space with clients while making adjustments.

5.3.3 Scripting

When architects work with scripting capabilities, enabling a visual scripting environment is always a good way to increase adoption even by those who do not write hard code. Some experienced architects can work with just a simple Software Development Kit, which usually calculates with a higher level of code writing skills. However, making such a software developer kit (SDK) as accessible as possible to code non-professionals might be another key aspect of architects using the Metaverse for their work.

5.3.4 Limitations

One large limitation of current Metaverse projects is the vertex count of imported 3D models. For example, Decentraland (2018) still holds this limit at 10 000 vertices per parcel which leads to very dramatic compromises in both modelling and interactions possible to be done. Another important limitation lies in textures. Their resolution is seldom limited to relatively small values like 512x512 px and the number of textures per model is also usually limited to just one. There are ways to overcome such limitations using baking different images into one texture, however, the resolution limitation makes it very hard to achieve reasonable results. In almost all current Metaverse projects, there is already some form of height limitation on users' parcels (Stinson, 2022). This has to be taken into account since the limitation is not parametric and usually applies to the whole explorable world. Comparing such general limitations with our physical cities will pave the way to more meaningful zoning rules for the Metaverse. A crucial limitation currently used in Metaverse projects is the file size for the uploaded models. This is understandable, however, could be replaced by web3 and decentralised storage implementations (Balduf et al., 2022) or loading data directly on user interaction from other storage. If this approach shall become one of the standards, it has to be streamlined and simple to employ, rather than a hack hidden in the forums.

5.4 Level of Gamification

One key question to be answered regarding the level of gamification is if the gamification principles do not invalidate some of the architects' use cases. For example, a platform time limit on being present in a new design would ruin the experience of the clients. Such an example is chosen ad absurdum, however, in subtler contexts a strong gamification principle might be obstructing a legitimate use case. Since many Metaverse projects might arise from actual video games and their engines (for example Fortnite, Roblox or Minecraft) their openness to new use-cases must be evaluated even though they might have been created as a creative sandbox game.

Architecture has been shaped by physics and gravity. Therefore, an automatic presence of physics will be welcome by architects, however being able to create own rules for more daring designs aimed only at the Metaverse should be an option available.

Metaverse themes also affect the gamification level. Some of the current Metaverse projects are loudly promoting their theme (space, cowboys, pokémon-like world…) which only constraints the possibilities of using the project in useful work for architecture. This is usually reflected by creator asset library content, environments and UI or even colours.

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5.5 Blockchain Integration

To secure authorship of creations and enable new business models for architects, a Metaverse must integrate blockchain/Decentralised ledger technologies, which create peer-to-peer economies to not rely on large Metaverse providers. The type of blockchain and its features will have an impact on some of the functionalities along with security and availability. For example, if Ethereum is selected, it automatically means users might avoid committing to transactions as much as possible due to the possibility of high network fees unless some of the layer 2 chains are supported.

Another important aspect is the level of tokenization. Is there a possibility for a space of new creations already a Non-Fungible Tokens, which the user must buy? Can the owner of a parcel, a virtual piece of land, delegate the right to build to his or her architect? Does each Metaverse have its own native fungible token to be used in transactions? Are all collectable in-game objects also NFTs? Is there a dedicated marketplace or can the items be traded outside each Metaverse? Are the creations compatible with other Metaverses, i.e. can one transfer a design across? An interesting criterion for the novel business plans of architects lies in the crypto-economics (rather tokenomics) of the Metaverse project. Are there any incentives to build new creations? Is there a Play2Earn mechanism? What are the mechanisms to create value? Can a successful design be reused? Are there royalties for the author if her or his design gets reused?

The governance of a Metaverse project is also of high importance. Blockchain allows ownership of the Metaverse by its users, allowing the collective decision-making for strategic decisions. After building one's portfolio in a Metaverse, one wants to keep a certain amount of control over the project through governance coins of it. There is also an interesting potential for satisfied customers who might form an alliance with their architect just based on similar values. On the other hand, the existence of a central entity to make decisions might help the project to succeed.

The last of the criteria based on blockchain integration is ownership of the Metaverse. Is it owned by a decentralised entity like a DAO or a private for-profit company? Such information might be useful in determining the long-lasting of one's creations.

5.6 User Experience

Any upcoming technology must persuade potential clients by having an inviting user experience. Only the early adopters usually withstand cumbersome workflows, misleading user interface (UI) and other obstacles. In order to welcome new architects to the Metaverse the process of creating a new account while learning about key principles of crypto and the tokenomics of the Metaverse has to be as smooth as possible to not create an entry barrier.

A clear and non-obtrusive user interface is very important. All the more if we take into account that modelling and designing is time-demanding work and achieving the flow state while doing so could be jeopardised by an annoying badly designed ever-present UI element or its interaction.

The same can be stated about the general ease of use. This criterion includes camera manipulation, movement, responsiveness, even sound design, building tools and the way one interacts with them and the overall feel of using the Metaverse as a tool. While some of the possible problems can be overcome by practice and training, even gamers tend not to invest a lot of time into something with hard-to-tame controls.

Finally, the level of interactivity will also play an important role. For example, a situation when an architect shows her or his design to the clients is undoubtedly a social one and the architect needs to pay attention to all the formal and informal signals his or her clients express. Failing to convey such information would deteriorate the Metaverse as a medium of social interaction.

5.7 Scoring Weights

We have assigned weights to all the sub-criteria via a discursive process within the research teams. This weighted system shall be taken as an initial attempt to classify and rate early Metaverse projects in order to discover knowledge gaps as well as gaps in the scoring itself. All the proposed weights are trying to reflect the importance the authors would give them.

Table 1. User Experience.

Platform		
20%		3D Standalone PC
20%		3D Standalone Mac
20%		VR
20%		Web Browser
10%		Mobile
5%		AR
2.50%		3D Standalone Linux
2.50%		Consoles
Visual Representation		
40%		Scale Accurate Objects
40%		Scale Accurate Avatars
10%		Position on the Stylization-Realism Scale
10%		Customizable Environment
Design Capabilities		
50%		Limitations
	40%	Vertex Count (at least 1 000 000 vertices per object)
	20%	Texture Resolution (at least 2048x2048 px)
	20%	File Size (at least 500 MB)
	10%	Parcel Height Limit (at least 2:1 of floor size)
	10%	Texture Count (at least 10 per object)
15%		Number Input while Modelling
10%		Snapping
10%		Asset Library
10%		Visual Scripting Environment
2.50%		glTF Integration
2.50%		SDK
Level of Gamification		
30%		Creating Own Rules
30%		No Mandatory Rules
20%		Absence of Theme
20%		Presence of Physics

Blockchain Integration		
50%		Blockchain Powered
12.50%		Tokenization and Utility
	33.30%	Spaces as NFTs
	33.30%	In-game Items as NFTs
	33.30%	Native Tokens
12.50%		Economics and Incentives
	30%	Play2Earn
	30%	Royalties
	30%	Multiple Ways to Create Value
	10%	Revenue Distribution
12.50%		Ownership
	75%	How much Decentralised is Owner
	25%	Clear Ownership
12.50%		Ownership
	75%	Involvement in Large Scale Decisions
	25%	Banning process for bad clients (reputation)
User Experience		
30%		Ease of Use
30%		User Interface
20%		Identity Creation
	75%	Information Required
	25%	Time to Create an Account
20%		Level of Interactivity
	20%	Spatio-social
	20%	Verbal
	20%	Written
	20%	Non-verbal
	10%	Visual
	10%	Monetary

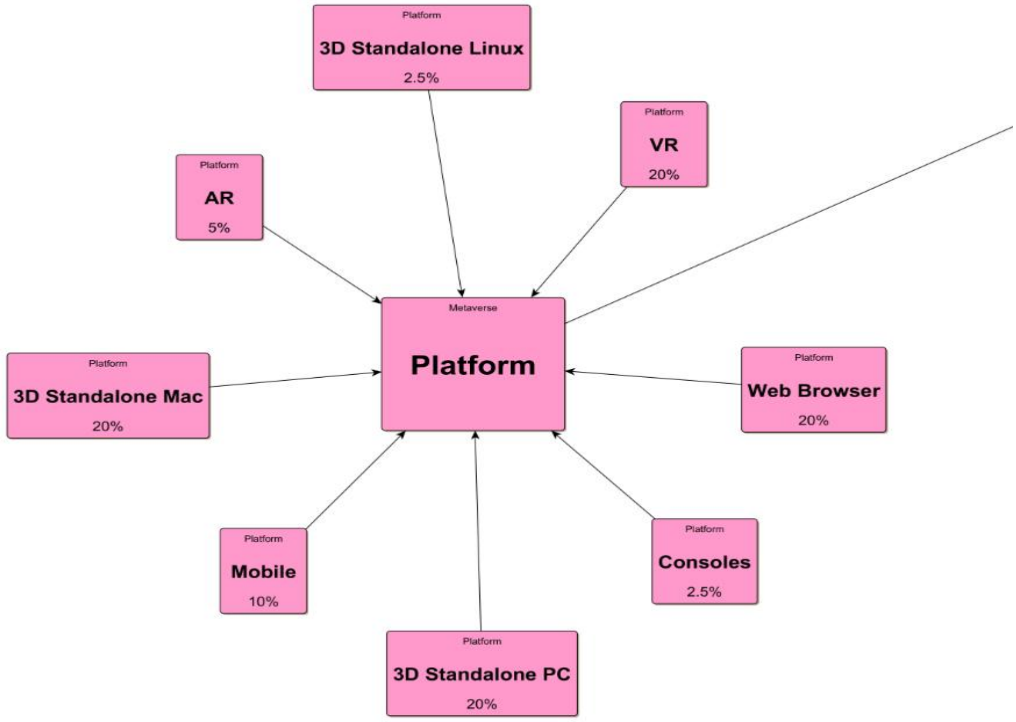

Fig.3: Platforms and their proposed weights.

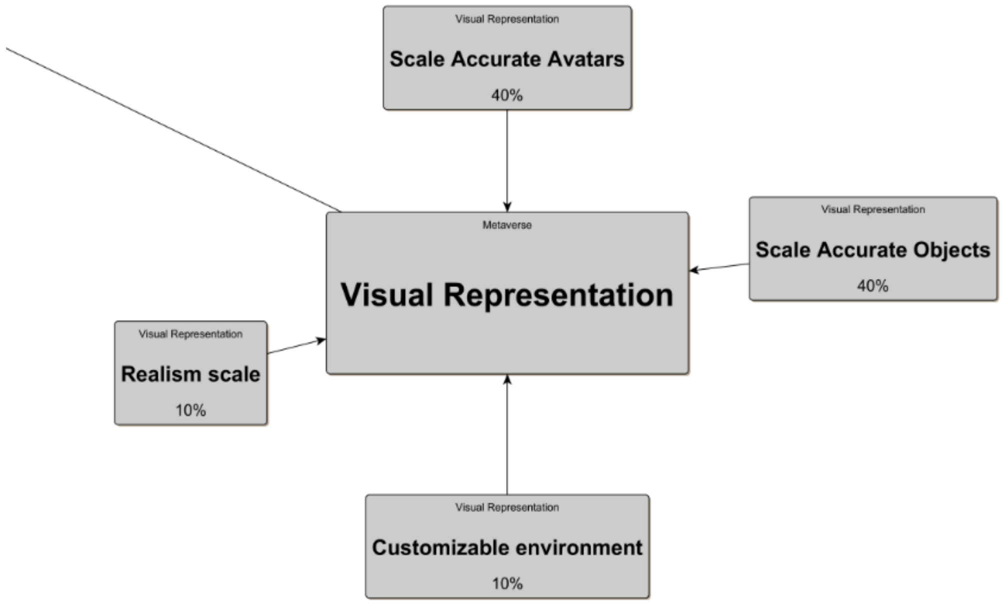

Fig.4: Visual representation and proposed weights.

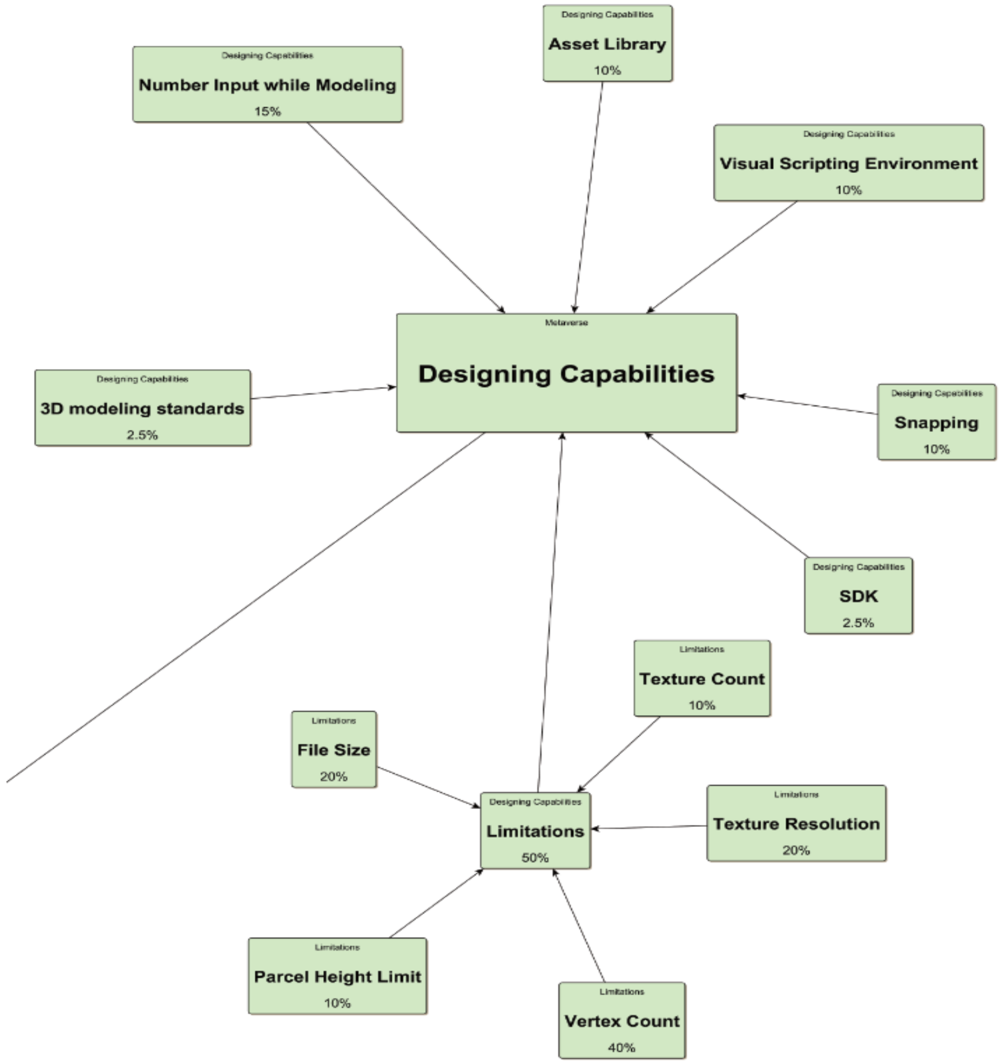

Fig.5: Design Capabilities and their proposed weights.

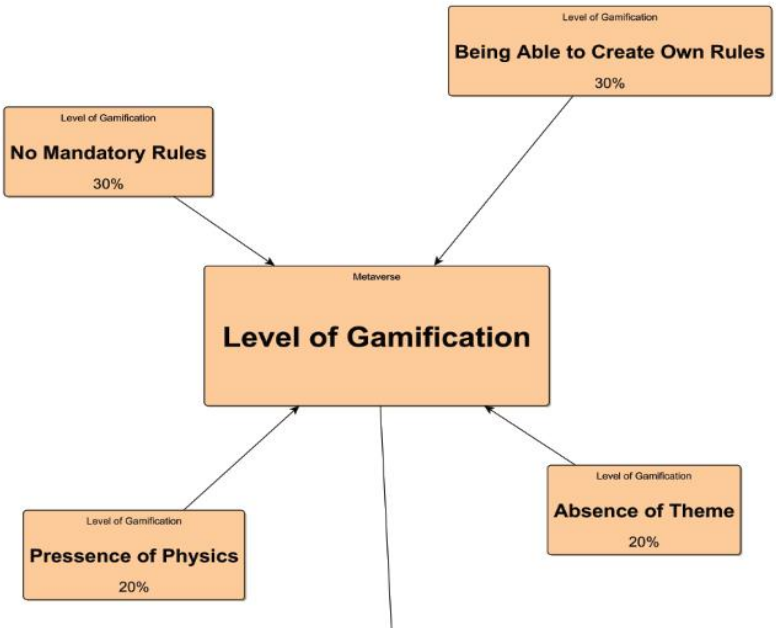

Fig.6: Level of gamification and proposed weights.

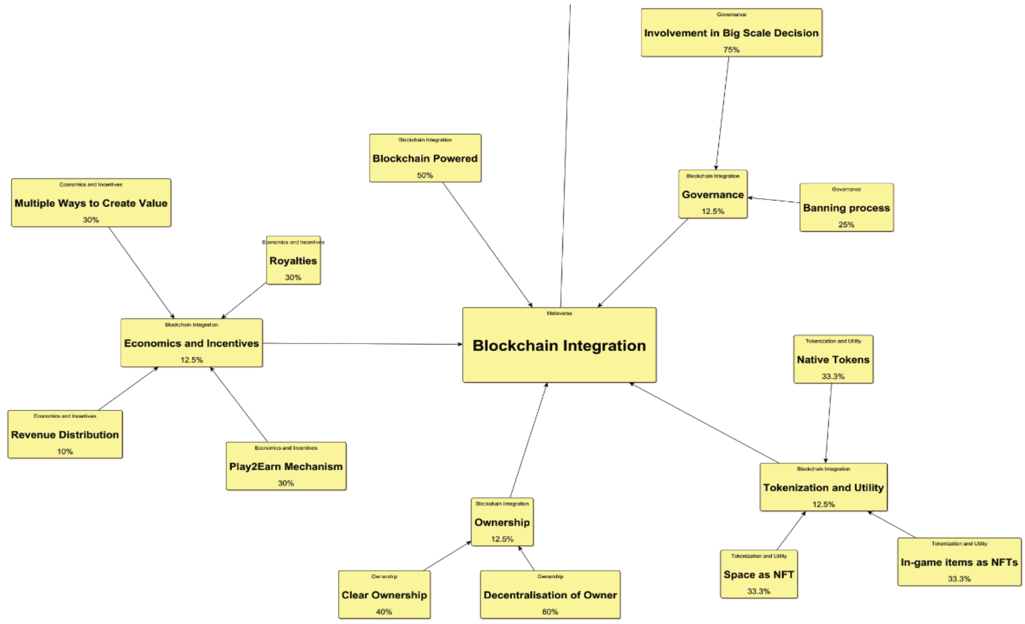

Fig.7: Blockchain Integration and proposed weights.

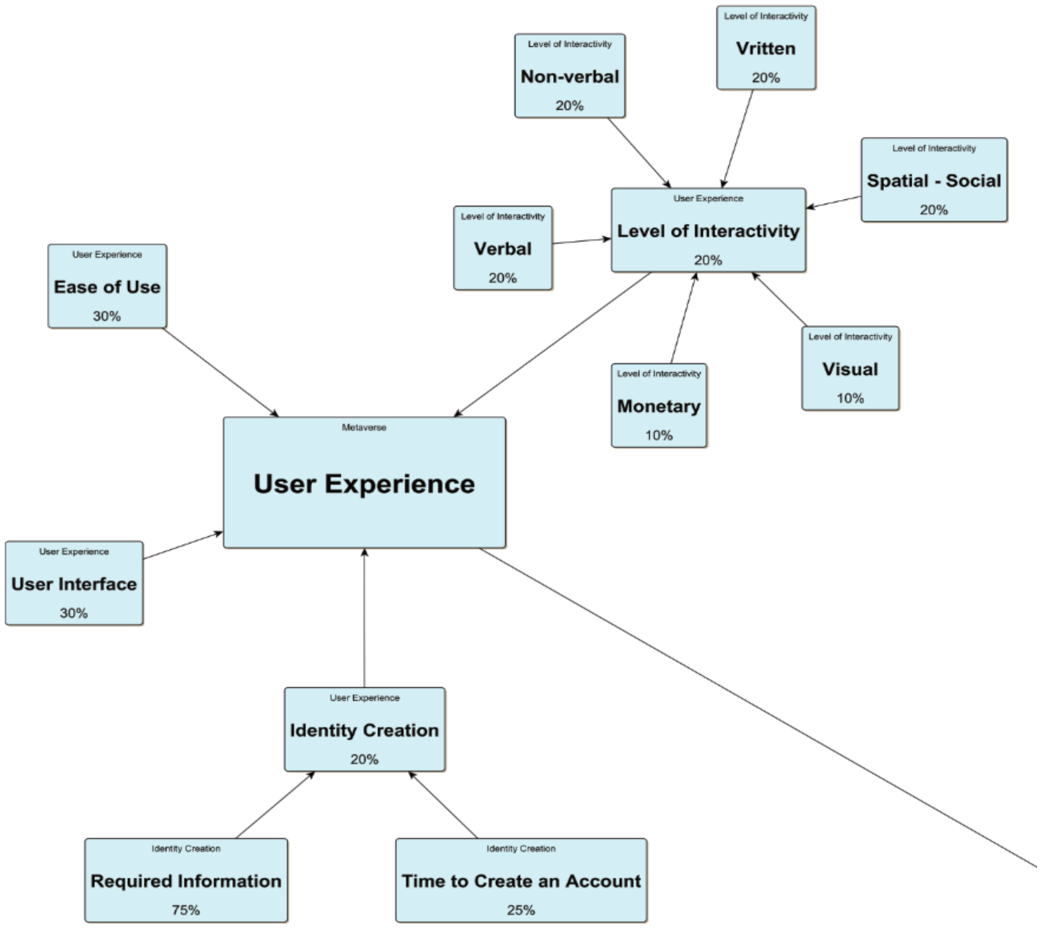

Fig.8: User Experience and proposed weights.

6. DISCUSSION AND KNOWLEDGE GAPS

The development of the Knowledge graph to evaluate Metaverses brought forward two main initial questions:

- What is the difference between a Metaverse and existing VR worlds, or even multi-player games?
- What will be crucial for adoption of the Metaverse: Will the increase in social interaction in such spaces play a role, or is the realistic rendering more important, along with perhaps other criteria?

Maver's framework (1995) might be productive here in developing our evaluative knowledge graph further but also testing it. There are also particular knowledge gaps in another adjacent knowledge area that is currently developing in architecture, that of the digital twins, where there might be spillover effects in terms of tools and concept development. The lack of benchmarks and standards is also a crucial area that might improve in the future, as currently, a researcher must navigate a lot of hype information and marketing speak rather than data that point towards true performance. The presented framework is a first attempt toward building those datasets, and we do not lay claim that our framework is complete or tested. We still have to also validate the knowledge graph via developing tests for further existing Metaverses, and within that, we might evaluate whether the framework as a set captures all of the criteria that are important, or whether there are also other indicators that might make a Metaverse useful to architects. Additionally, we believe that a wide knowledge gap is the user experience and the view the user might have in such an endeavour. For that we propose that a framework from the side of the user is developed, one that might be easy to customise for the specific type of usage, for example, social interactions, work or gaming. We foresee that there might be interesting bridges between the Metaverse framework for architects and ones for the users, where the user framework feeds into the architecture one.

7. CONCLUSION & FUTURE WORK

The existence of early Metaverses along with the communities that cater to them, acts against the hype of the Metaverse, solidifying the idea that architects can use the Metaverse, both for and in Architectural Design. The Metaverse building tools are at the moment crude and not well integrated, but we envision that our evaluation knowledge graph can provide architects with an easy to use, handy tool to plan ahead in using the Metaverse in their projects, but also for Metaverse creators to shape their platforms in manners that will allow architects to use them in a valuable manner. We look forward to developing this research into the rest of the DSR activities with prototype but also further validation of our evaluation graph and framework.

A follow up survey will be conducted with ArchiDAO's Discord members. They will be asked to assign weights to mentioned criteria according to their own subjective experience in current metaverse projects. After aggregating all such data we'll be able to validate our suggested weights with statistical significance as well as probably include new ones not thought of yet.

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